The Medical Test Planning System (MTPS)

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This abstract describes a computer-based system that performs automated planning and scheduling of medical tests. Automated planning has application in domains such as medical test planning that require labor-intensive reasoning to synthesize a plan. Planning can be characterized as a search of all possible combinations of steps, with the resulting plan being one that transforms an initial state into a goal state. In most real-world planning problems, the number of possible combinations of steps is prohibitively large. Therefore, artificial intelligence search techniques are used to limit the number of combinations that must be considered to find a plan.

During execution, the Medical Test Planning System (MTPS) acquires a presumptive diagnosis for one or more patients, selects appropriate medical tests, orders the selected tests, and schedules the tests based on the available resources. The medical tests cover a subset of tests for hepatobiliary, pancreatic, and gastrointestinal disorders. Resources include equipment, personnel, supplies, and time. When the user specifies one or more disease hypotheses for a patient, a knowledge base of rules selects the appropriate medical tests. This knowledge base evaluates contraindications and resource availability. Based on a patient-state model, the system orders these tests by patient. An hourly schedule is then constructed that takes into account resource conflicts and time constraints. When conflicts cannot be resolved, the system re-selects or re-orders the most constrained tests based on an analysis by an intelligent backtracking agent.

The MTPS was developed using a variety of intelligent system programming techniques, including knowledge-based systems and blackboard architectures. The MTPS is a multi-agent system for planning and scheduling medical tests. We approached the problem by identifying three primary reasoning agents: medical test selection, medical test ordering (or sequencing), and medical test scheduling. The overall system architecture is illustrated in the figure below. Each agent uses an independent method to arrive at a solution. The agents communicate via a global data structure called the plan blackboard. The output from each agent is stored on the plan blackboard for use by the other agents. A controller determines the order in which the agents act. The use of multi-agent architectures in knowledge-based systems is increasing with the recognition that complex, difficult tasks need to be decomposed into smaller sub-tasks and that each sub-task should be solved with the most appropriate reasoning technique. Each of the main agents is responsible for solving a sub-task of the larger problem. Though some of the issues addressed by this research were specific to the domain of medical testing, the approach and architecture for planning and scheduling is general.
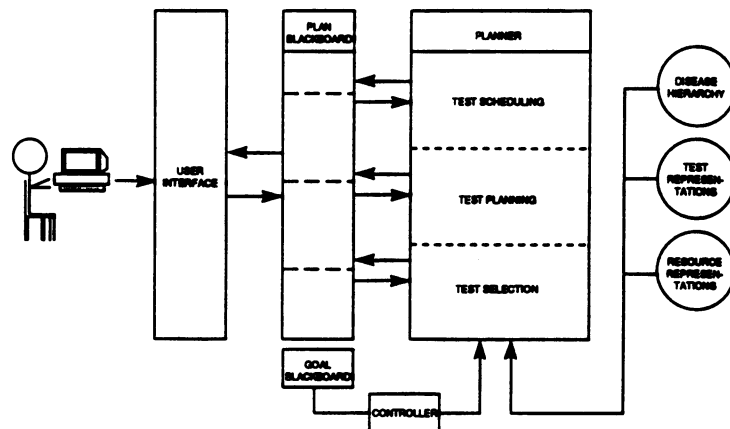
Overview of the medical test planning system